

# Redescription and new records of freshwater Nematomorpha (Gordiida) from Chile, with the description of two new species

## Redescripción y nuevos registros de Nematomorpha (Gordiida) de Chile con la descripción de dos nuevas especies

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### ABSTRACT

Only four species of Gordiida (Nematomorpha) are known from Chile. This paper describes two new species *Gordionus enigmaticus* and *Gordius austrinus*. *Gordionus enigmaticus* is characterized by the variation in the shape of the areoles along the longitudinal ventral furrow and by the absence of the precloacal fields of bristles at the terminal end. *Gordius austrinus* can be distinguished from other *Gordius* species by the presence of the precloacal ledge bounding the cloacal area depression, by the cuticular prominence where the cloacal opening lies and by the distribution pattern of the bristles at the posterior end. Likewise, *Gordius paranensis*, *Gordius robustus* and *Neochordodes meridionales* are ultrastructurally redescribed and the distribution of each of them in Chile is given.

**Key words:** Nematomorpha, Chile, distribution, new species.

### RESUMEN

Hasta el momento solo han sido citadas para Chile cuatro especies de Gordiida (Nematomorpha). En este trabajo se describen dos especies nuevas, *Gordionus enigmaticus* y *Gordius austrinus*. *Gordionus enigmaticus* se caracteriza por la variación en la forma de las areolas a lo largo del surco longitudinal ventral y porque en la región pre-cloacal del extremo posterior, los campos de cerdas están ausentes. *Gordius austrinus* se distingue de otras especies de *Gordius* por la presencia de un reborde precloacal que limita la depresión del área cloacal, por la prominencia cuticular donde se encuentra la abertura cloacal y por el patrón de distribución de las cerdas en el extremo posterior. Asimismo se redescriben ultraestructuralmente a *Gordius paranensis*, *G. robustus* y *Neochordodes meridionales* y se señala la distribución para Chile de cada especie.

**Palabras clave:** Nematomorpha, Chile, distribución, especies nuevas.

### INTRODUCTION

Gordiida (Nematomorpha) or horsehair worms, as they are commonly called, because of the popular notion that they arise from horse hair falling into water, have some affinities with Nematoda. In the traditional literature the name "Aschelminthes" was used in order to group the Rotifera, Acanthocephala, Nematomorpha, Nematoda, Gastrotricha, Kinorhyncha, Priapulida and Loricifera. Recent ultrastructural and morphological studies and the analyses of 18r DNA gene sequences (Winnepeinckx et al. 1995) suggest that "Aschelminthes" has a polyphyletic origin

constituted by three different clades, and should not be considered a valid taxon (Kristensen 1995, Ehlers et al. 1996, Aguinaldo et al. 1997, Garey & Schmidt-Rhaesa 1998). At present, Nematomorpha and Nematoda constitute a sister group that was named Nematoidea by Schmidt-Rhaesa (1996).

The life cycle of Gordiida consists of a free-living and a parasitic phase. The adults copulate in freshwater and the tiny larvae hatch from eggs and infect a variety of invertebrates (Schmidt-Rhaesa 2001, Schmidt-Rhaesa & Ehrmann 2001, De Villalobos & Ronderos 2003, De Villalobos et al. 2003a, Hanelt & Janovy 1999, 2002, 2004).

To date about 300 species of Gordiida have been described. The taxonomy of this taxon is mainly based in male specimens, on the features of the posterior end and on the cuticular structure of the body wall. The most original descriptions were realised on light microscopy (LM). These descriptions in many cases, fail to give adequate diagnostic characters. New observation techniques, especially the scanning electron microscopy (SEM) allows to analyse fine structural details and have become a standard in Gordiida taxonomy.

The Gordiida from South America, except for Argentina (see among the others Miralles & De Villalobos 1996a, 1996b, 1996c, De Villalobos & Voglino 2000, De Villalobos & Zanca 2001, De Villalobos et al. 2003b, 2004), are insufficiently studied. Particularly for Chile, the Gordiida fauna is almost unknown. Only twelve specimens are recorded in the literature that are assigned to four species: *Beatogordius latastei* (Camerano 1895) from Santiago (one male: Camerano 1895), *Neochordodes talensis* (Camerano 1897) from El Salto, Quilpué (one male, Camerano 1915), *Gordius aquaticus* (Linneus 1758) from Valparaíso (one female, Römer 1895), *G. paranensis* Camerano 1892 from Casablanca (five males and one female, Montgomery 1898) and from El Salto, Quilpué (one male and two females, Camerano 1915). Other specimens from Valparaíso, Concepción and other provinces (Blanchard 1849) and Santiago (Lataste 1896) have been assigned to *Gordius chilensis* Blanchard 1849, but this species was considered untenable due to insufficient description (Römer 1897, Camerano 1895, 1897, 1915, Montgomery 1898).

The aim of this paper is to widen the information about the biodiversity of the Gordiida of Chile. Three species (*Gordius paranensis*, *Gordius robustus* and *Neochordodes meridionales*) are ultrastructurally redescribed by SEM and two new species (*Gordionus enigmaticus* and *Gordius austrinus*) are described. The distribution of each of them in Chile is given.

#### MATERIAL AND METHODS

The specimens from Chile are from the collection of the Museum of Zoology,

Concepción University (MZUC), Concepción, Chile. Body measurements of 41 specimens (23 male and 19 female) of gordiids were made with outstretched worms using a ruler. Diameters were measured under dissecting microscope using a calliper ruler. For examination by SEM, whole sections were taken from the middle and posterior end of the body. Fragments of all the worms studied were dehydrated in an increasing ethanol series, critical point-dried, mounted on bronze blocks and gold-sputter coated. Observations were performed using a JEOL SLM 1000 scanning electron microscope.

#### RESULTS

*Gordionus enigmaticus* n. sp. (Fig. 1A, 1B, 1C, 1D, 1E)

*Gordionus enigmaticus* n. sp.

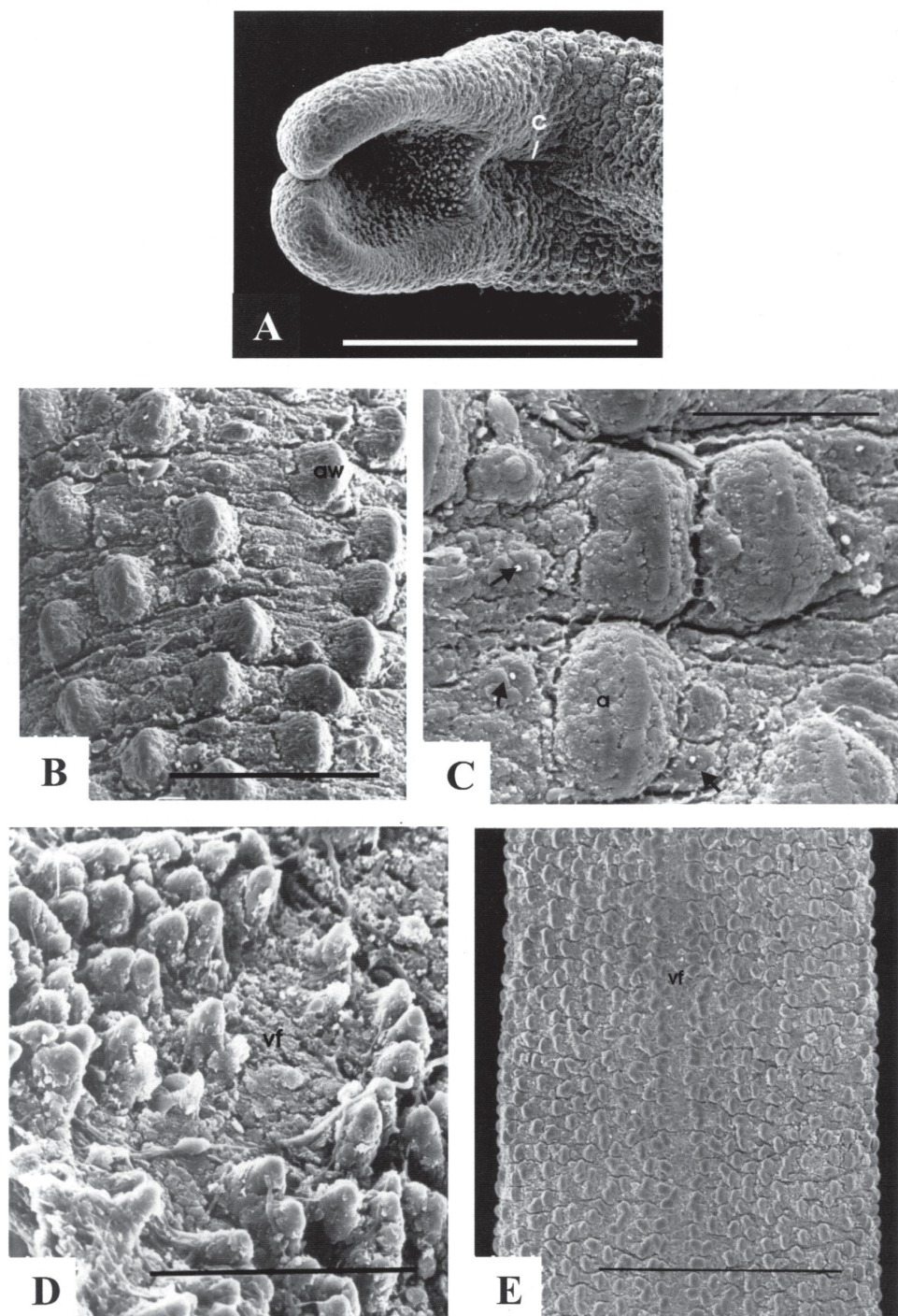
Holotype: male from type locality, MZUC 26325.

Type locality: X Región 35 km from Corral. Puente Las Minas col Ribera I. 28/1/99.

Material investigated: holotype (SEM of midbody and posterior end).

Description: body color dark brown. In the anterior end a white cap and a dark collar are lacking. Posterior end bilobed (Fig. 1A). Tail lobes short (31.9 µm in length and 24.4 µm in wide). The cloacal opening is round, circumcloacal spines are completely absent. Numerous conic spines present posterior of the cloacal opening and extending onto the inner side of the tail lobes. Precloacal bristlefields are lacking completely. Specialized areoles called adhesive warts are present ventrolaterally in the midline anterior of the cloacal opening (Fig. 1B). These adhesive warts are oriented along the longitudinal axis of the body at a distance of 0.8 mm of the cloacal opening. They are oval, protuberant and their mid-line is keel-like (23.4 µm high).

The body cuticle is densely structured by areoles (Fig. 1C). The areoles are oval (50.7 µm in length, 36 µm wide and 20 µm high) with a smooth surface. The longitudinal axis of the areoles is parallel to the longitudinal axis of the body. Scattered between the areoles are structures that have a rounded basis with a very small tubercle on top which look like tubercle areoles (Fig. 1C).



*Fig. 1: Gordionus enigmaticus* n. sp. (A) Posterior end; scale: 100 μm. (B) Anterior region of the cloacal opening showing the adhesive warts; bar: 100 μm. (C) Cuticle of the medial region of the body; reference: a areole, structures like tubercle areoles (arrows); scale: 50 μm. (D) Ventral furrow of the posterior region of the body; scale: 50 μm. (E) Ventral furrow of the medial region of the body; scale: 500 μm; reference: aw adhesive warts, c cloacal opening, vf ventral furrow.

*Gordionus enigmaticus* n. sp. (A) Extremo posterior; escala 100 μm. (B) Región anterior de la hendidura cloacal mostrando las estructuras adhesivas; escala: 100 μm. (C) Cutícula de la región media del cuerpo; referencia: a areola (flechas), estructuras semejantes a las areolas tuberculadas; escala: 50 μm. (E) Surco ventral de la región media del cuerpo; escala: 500 μm; referencia: aw estructuras de adhesión, c hendidura cloacal, vf surco ventral.



Along the body, at the level of the ventral furrow the areolar pattern differs, being limited at the mid posterior region by conic areoles (15.8  $\mu\text{m}$  high) (Fig. 1D) while in the mid anterior region it is limited by the same areoles observed in the rest of the cuticle (Fig. 1E).

Dimensions: one male 105 mm length and 0.3 mm width.

Remarks: the presence of a bilobed terminal end, the adhesive warts and body cuticle with one type of areoles make *Gordionus enigmaticus* belong to the genus *Gordionus*. *G. enigmaticus* as described for *Gordionus alascensis* (Montgomery, 1907) (Schmidt-Rhaesa et al. 2003), *G. longareolatus* (Montgomery, 1898) (Schmidt-Rhaesa et al. 2003) and *Gordionus sinopilosus* Schmidt-Rhaesa, Hanelt and Reeves, 2003 (Schmidt-Rhaesa et al. 2003) lacks the precloacal fields of bristles. The absence of these bristlefields is an unusual pattern which separates these last four species from other *Gordionus* species. *Gordionus enigmaticus* differs from *G. alascensis* in the presence of bristles or spines on the posterior end and in the absence of a parabolic integumentary ridge anterior of the cloacal opening. The cuticle of *G. longareolatus* contains scattered and elevated tubercles between the areoles (Montgomery 1898), while in the interareolar furrow of *G. sinopilosus* numerous bristles are found (Schmidt-Rhaesa et al. 2003). In *G. enigmaticus* the only interareolar structure is a rounded basis with a very small tubercle on top. These structures remain tubercle areoles of *Beatogordius abbreviatus* (Villot, 1874) (Schmidt-Rhaesa & De Villalobos 2002). *Gordionus enigmaticus* is distinguished from other species of the genus by the variation in the shape of the areoles along the longitudinal ventral furrow.

*Gordius austrinus* n. sp. (Fig. 2A, 2B, 2C, 3A, 3B, 3C)

*Gordius austrinus* n. sp.

Holotype: male from type locality (MZUC 26286a). Paratypes: five males (MZUC 26286) and one female (MZUC 26292) from type locality.

Type locality: Concepción, Agüita de la Perdiz. Pozo de Vertiente, Chile col. Jara J. 19/6/83.

Host: unknown.

Additional specimens: Chile: one ♀ (MZUC 26298) Concepción; collector Artigas J. 23/6/92; one ♀ (MZUC 26284), Concepción 37°00' S, 72°30' W; collector Artigas J. 17/5/96; one ♀ (MZUC 26285), Ñuble. Niblinto stream 20/3/97; one ♀ (MZUC 26327), Cherquenco Fundo Venecia, Lan-Lan stream; collector Ribera I. 7/2/99; one ♀ (MZUC 26294), Caracol hill; collector Quezada A. 8/94; four ♀♀ (MZUC 26302) and two ♂♂ (MZUC 26307), Caracol hill, Concepción; collector Olmos V. 11/2000; one ♀ (MZUC 26295), Pedro Valdivia; collector Urrea L. 8/2002; one ♀ (MZUC 26296), Valdivia Mehuin Colegual; collector Ibarra-Vidal H. 21/1/2001; one ♀ (MZUC 26299), Cautín province. Villarrica lake; collector Moyano H.I. 12/2/78; one ♀ (MZUC 26301), Iquique; collector Well F. 19/12/68; six ♀♀ (MZUC 26308) and 11 ♂♂ (MZUC 26324), Chillán (Las Mariposas); collector Cáceres 16/5/94.

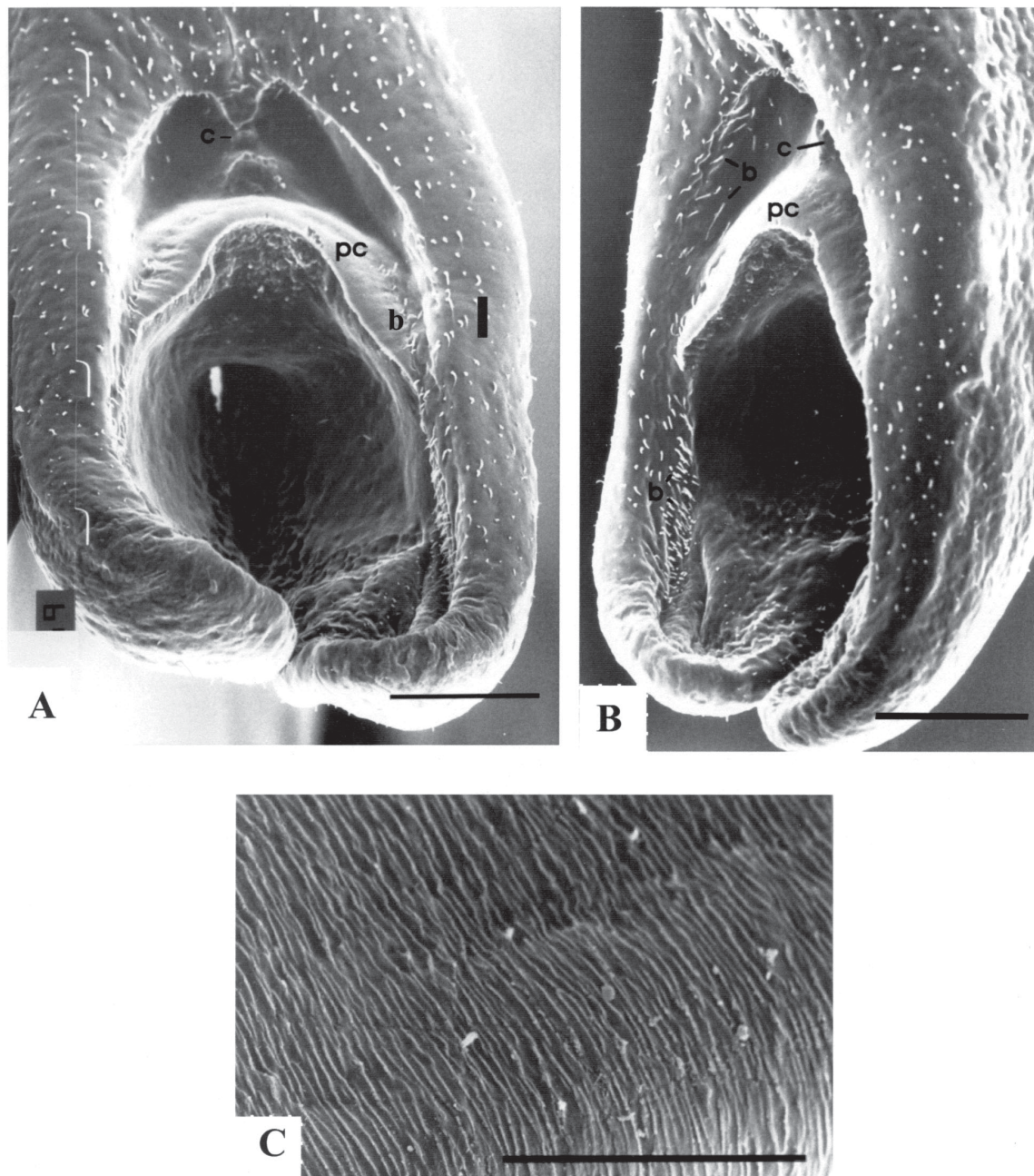
Material investigated. SEM: midbody and posterior end: holotype, paratypes (two males and one female) and one female (MZUC 26285); two females (MZUC 26302), two males (MZUC 26307), one female (MZUC 26308) and three males (MZUC 26324).

Description. Holotype: body color dark brown. In the anterior end a white cap is absent. Distinct white spots are present in the cuticle of the body. Posterior end bilobed, the lobes are moderately long 0.21 mm and 0.12 mm wide and not diverging (Fig. 2A). The apex of the lobes forms a spoon shaped cavity in which small bristles can be observed. Posterior of the cloacal opening is a semicircular postcloacal crescent with a row of bristles on its lateral borders (Fig. 2A). Anterior to the post cloacal crescent there is a depression with a central cuticular protuberance where the cloacal opening lies (Fig. 2A, 2B). The cuticle in this depression is smooth. In the precloacal region there is a parabolic intergumentary ledge which bounds the cloacal depression. In the internal borders of the precloacal ledge and extending onto the inner side of the tail lobes there are bristles unbranched (Fig. 2B). These bristles are longer and more numerous than the bristles on the cuticle of the lateral borders of the lobes (Fig. 2A, 2B).

The body cuticle shows transverse oriented slender folds with scattered short bristles (Fig. 2C). In the other specimens investigated the body color is variable, males from Chillán

(MZUC 26324) are light yellowish but the others are dark brown. The anterior end in lightly colored specimens, with a white cap followed dark collar. A dark coloration is present on the postcloacal crescent in lightly

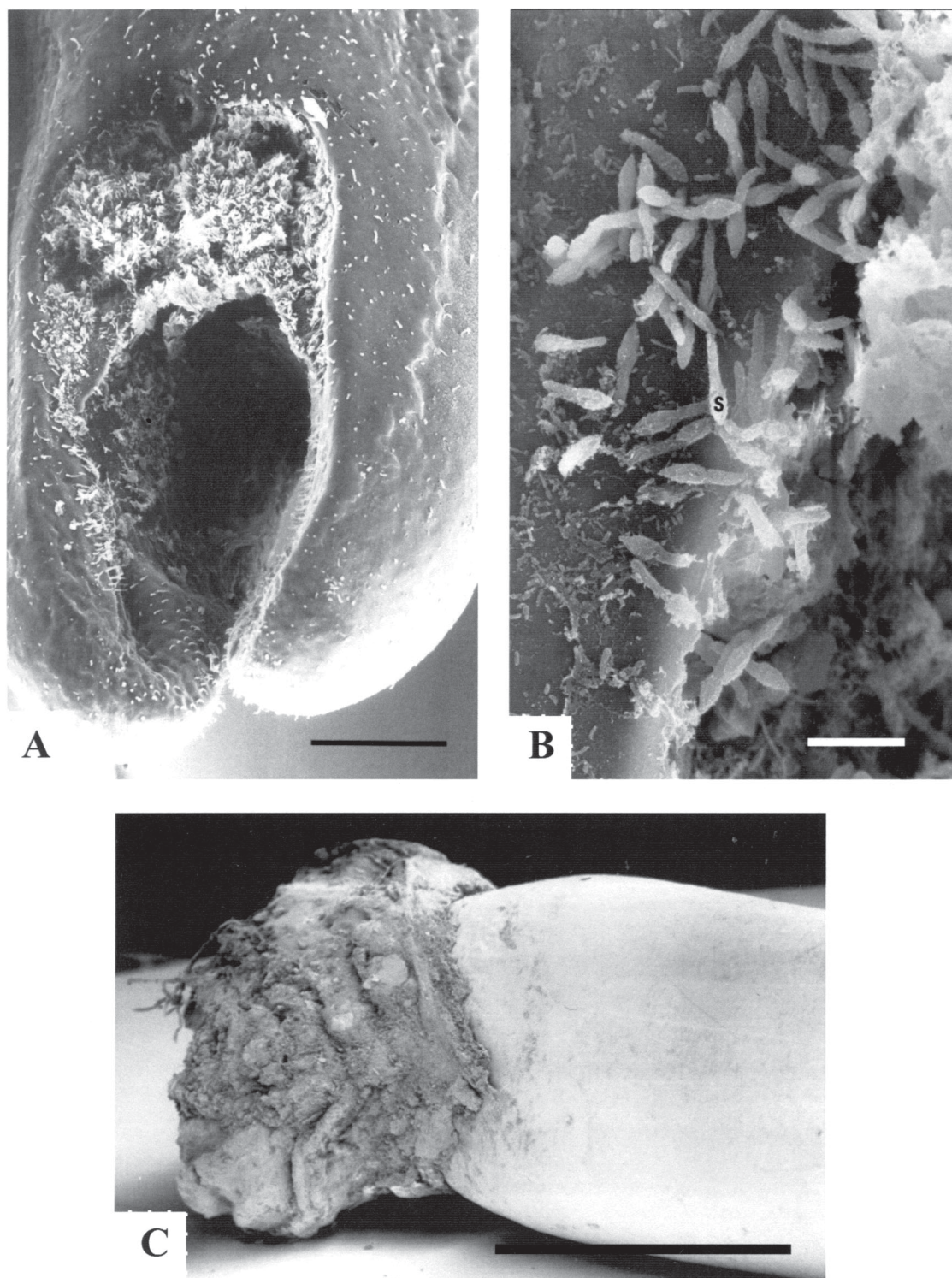
colored specimens. Lobes vary (0.26 to 0.49 mm long), (0.16 to 0.25 mm width). The terminal end and body cuticle of the males examined showed the same features than the holotype.



*Fig. 2: Gordius austrinus* n. sp. (A) Ventral view of the posterior end. (B) Lateral view of the posterior end. (C) Cuticle of the medial region; reference: c cloacal opening, cp post cloacal crescent, b bristle, l lobes; scales: 100  $\mu$ m.

*Gordius austrinus* n. sp. (A) Vista ventral del extremo posterior. (B) Vista lateral del extremo posterior. (C) Cutícula de la región media del cuerpo; referencia: c hendidura cloacal, cp medialuna postcloacal, b, cerda, l lóbulos; escala: 100  $\mu$ m.





*Fig. 3: Gordius austrinus* n. sp. (A) Posterior end of male (MZUC 26324) showing a sperm mass; scale: 100  $\mu$ m. (B) High magnification of sperm mass; scale: 10  $\mu$ m. (C) Female terminal end (MZUC 26302) covered by a mass of eggs; scale: 500  $\mu$ m; reference: s spermatozoa.

*Gordius austrinus* n. sp. (A) Extremo posterior del macho (MZUC 26324) exponiendo la masa de esperma; escala: 100  $\mu$ m. (B) Masa de esperma con mayor resolución; 10  $\mu$ m; (C) Extremo posterior de la hembra (MZUC 26302) cubierto con una masa de esperma; escala: 500  $\mu$ m; referencia: s espermatozoos.

At the terminal end of one male (MZUC 26324) there was a sperm mass completely covering the depression where the cloacal opening is found (Fig. 3A, 3B).

Dimensions. Holotype: 263 mm in length and 0.6 mm in diameter. The length of the other 19 specimens measured varies between 133 mm and 438 mm with an average length of 331 mm. The diameters vary between 0.4 mm to 0.6 mm.

Female. The body color of 20 specimens observed ranged from dark brown (Valdivia, Cherquenco and Iquique specimens) to light brown (the other specimens). The white spots of the cuticle are lacking. Only the females with light color have a white calotte and dark collar at the anterior end. The body cuticle is smooth. The terminal end in all the females analyzed is covered by a mass of eggs (Fig. 3C).

Dimensions. Females measurements vary from 245 to 675 mm (average 407 mm) in length and from 0.6 to 1.2 mm in diameter.

Remarks. *Gordius austrinus* is separated from other *Gordius* species by the presence of the precloacal ledge bounding the cloacal area depression, by the prominence where the cloacal opening lies and by the distribution patterns of the bristles at the posterior end. *Gordius austrinus* specimens show variability in some characters. They exhibit differences in body color, varying from light yellow to dark brown, along the body and along the lobes of the terminal end of males. Likewise, the specimens with light color have a white calotte and a dark collar at the anterior end not observed in the dark brown specimens. Females differ from males not only at the posterior end but by the presence of a smooth cuticle without transverse oriented slender folds with scattered small bristles observed in the cuticle of males. This characteristic could be considered as a sexual dimorphism.

Taking into account that the new species as well as the one pointed for *G. chilensis* has a wide distribution for Chile, these specimens could have been assigned to *G. chilensis*. Nevertheless, it is very difficult to consider *G. chilensis* as a valid species due to the insufficient characteristics of its description by Blanchard (1849) as well as to its specimens which unfortunately seem to be lost.

Distribution (Fig. 7). Chile: Concepción, Agüita de la Perdiz, Pozo Vertiente (five ♂♂, one ♀); Concepción (one ♀); Concepción

37°00' S, 72°30' W (one ♀); Ñuble, Niblinto stream (one ♀); Cherquenco Fundo Venecia, Lan-Lan stream (one ♀); Caracol hill (five ♀♀, two ♂♂); Pedro Valdivia (one ♂); Valdivia Mehuin Colegual (one ♀); Cautín province, Villarrica lake; Iquique (one ♀); Chillán, Mariposas (11 ♂♂, six ♀♀).

*Gordius paranensis* Camerano, 1892 (Fig. 4A, 4B, 4C)

*Gordius paranensis* Camerano, 1892, p. 965.

Holotype. One ♂ Palmeira Parana, Brazil.

Additional specimens. Two ♀♀, one ♂ Asunción Paraguay (Camerano 1894, 1897), four ♂♂, one ♀ Villarica and Monda-y stream, Paraguay (Camerano 1901a), three ♂♂ Urucum Matto Grosso, Brazil (Camerano 1901b), six ♂♂ Casablanca, Chile (Montgomery 1898), one ♂, two ♀♀ Salto, Quilpué, Chile (Camerano 1915), one ♂ Puyehue Chile, collector Ribera I. 31/1/99 and 19 ♂♂ South Island of New Zealand in a small stream at Cass (43°02' S, 171°45' E) near Arthurs Pass (mountains of Canterbury) (Schmidt-Rhaesa et al. 2000).

Material examined. SEM. Puyehue, collector Ribera I. 31/1/99 (one ♂ MZUC 26326).

Host. *Pleioplectron simplex* Hutton 1897 (Raphidophoridae, Orthoptera) (Schmidt-Rhaesa et al. 2000).

Description. Male: body color brown with white spots on the cuticle. Anterior tip of the body rounded. A white calotte and a dark collar on the anterior end are not present. Posterior end is bilobed (Fig. 4A). Tail lobes are 0.29 mm long and 0.14 mm wide. Cloacal opening is round and without circumcloacal spines. Anterior of the cloacal opening is a semicircular row of bristles. The length of the bristles varies between 8 µm and 19 µm, some of them are bifurcated apically (Fig. 4A and 4B). Posterior of the cloacal opening is a semicircular crescent. Around the cloacal opening the cuticle is smooth.

Body cuticle is smooth and only structured by a rhomboidal pattern, which is due to underlying cuticular fibers arranged in cross layers (Fig. 4C).

Distribution. South America: Paraguay: Asunción (one ♀ Camerano 1894, one ♂ Camerano 1897), Villarica and Monda-y stream



(four ♂♂, one ♀ Camerano 1901a). Brasil: Palmeira, Paraná (one ♂, one ♀ Camerano 1892), Urucum Matto Grosso, (three ♂♂ Camerano 1901b). Chile (Fig. 7) Casablanca, (six ♂♂ Montgomery 1898), Salto, Quilpué, (one ♂, two ♀♀ Camerano 1915); Puyehue (one ♂ new record); New Zealand: South Island in a small stream at Cass (43°02' S, 171°45' E) near Arthurs Pass (mountains of Canterbury) (19 ♂♂ Schmidt-Rhaesa et al. 2000).

Dimensions: 335 mm length and 0.4 mm in diameter.

Remarks. Schmidt-Rhaesa et al. (2000) redescribed ultrastructurally for the first time specimens of *Gordius paranensis* from New Zealand and from Chile. These specimens differ from this new specimen from Salto Quilpué, in

the bristles which are arranged in a parabolic row anterior of the cloacal opening and are not furcated apically. This feature is important because no intraspecific variations for *G. paranensis* have been cited to date. The report of *Gordius paranensis* from North America by Chandler (1985) results from an erroneous citation of Montgomery (1898) (Schmidt-Rhaesa et al. 2003). The presence of a semicircular row of bristles was pointed by Smith (1994) for *Gordius difficilis* Smith, 1994 but this species differs from *G. paranensis* in the body cuticle which contains polygonal areoles and in the postcloacal crescent which is V-shaped. Montgomery (1898) cited this species from the locality of "Casabianca" which we changed to Casablanca, the correct name for Chile.

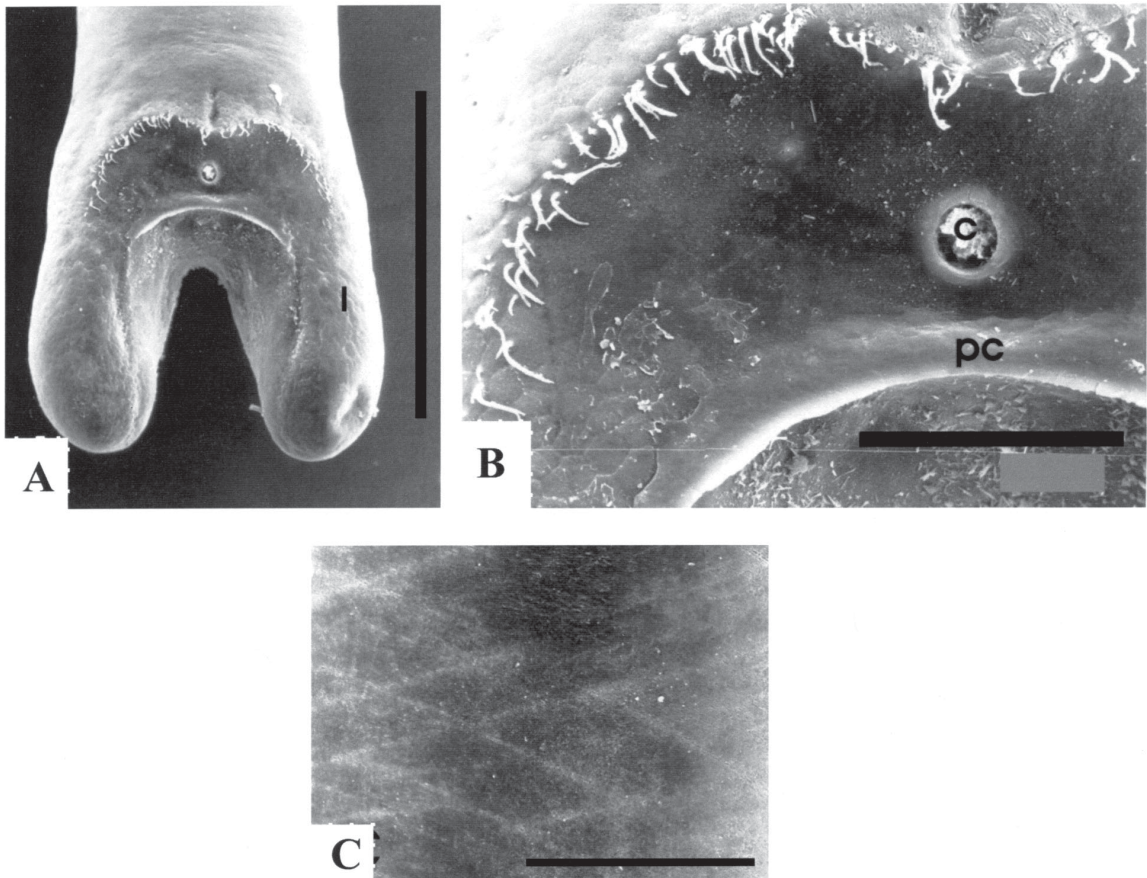


Fig. 4: *Gordius paranensis*. (A) Male posterior end; scale: 50 µm. (B) High magnification of the post-cloacal crescent; scale: 100 µm. (C) Cuticle of the medial region of the body; scale: 100 µm; reference: c cloacal opening, l lob, pc post cloacal crescent.

*Gordius paranensis*. (A) Extremo posterior del macho; escala: 50 µm. (B) Medialuna postcloacal con gran aumento; escala: 100 µm. (C) Cutícula de la región media del cuerpo; escala: 100 µm; referencia: c hendidura cloacal, l lóbulo, pc medialuna post-cloacal.



*Gordius robustus* Leidy 1851 (Fig. 5A, 5B)

*Gordius robustus* Leidy 1851, p. 266.

Holotype. Female, New Jersey.

Type locality. Pemberton, Burlington Co., New Jersey.

Material investigated. One male (MZUC 26293) from Chile, VIII Región, Penco 33°44' S, 72°59' W, collector Fernández L. 4/8/97.

Description. Body color uniformly dark brown, without white spots. The Body measurement is 453 mm in length and 0.8 mm in diameter. The terminal end is bilobed, tail lobes are 0.32 mm in length and 0.25 mm in wide. The postcloacal crescent is semicircular (Fig. 5A). Body cuticle is smooth with scattered bristles (Fig. 5B).

Host. See list in Schmidt-Rhaesa et al. (2003).

Remarks. The specimen (one female) from Valparaíso described as *Gordius aquaticus* by Römers (1895) must be renamed as *Gordius robustus*. Although *G. aquaticus* and *G. robustus* are characterized by the absence of diagnostic characters (Schmidt-Rhaesa et al. 2003), *G. aquaticus* is an entirely Palearctic species (see Schmidt-Rhaesa 1997) and *G.*

*robustus* is reported from Nearctic region and also from several locations in Central and South America (Miralles 1976, Miralles & De Villalobos 1993, Schmidt-Rhaesa et al. 2003).

*Neochordodes meridionalis* (Carvalho and Feio 1950) (Fig. 6A, 6B)

*Pseudochordodes meridionales* Carvalho & Feio 1950 p. 202.; *Neochordodes meridionales* Miralles & de Villalobos 1996a, p. 147.

Type locality. Salta, Copaffut, Zanja Honda.

Material investigated. One male (MZUC 26299) from Linares province, Paso Pehuenche, collector Ibarra-Vidal H. 2/95.

Description. Body color dark brown. Anterior end is tapering; without dark collar. Posterior end is rounded (Fig. 6A). Cloacal opening is oval and surrounded by long and unbranched circumcloacal spines. Cloacal opening is situated a long distance from the apex of terminal end (187 µm). Anterolateral of the cloacal opening are two narrow rows of scattered bristles. Cuticle (Fig. 6B) is densely structured by one type of variable size areoles randomly arranged or forming groups of 2, 3, 4 or 5. Generally two larger areoles are close

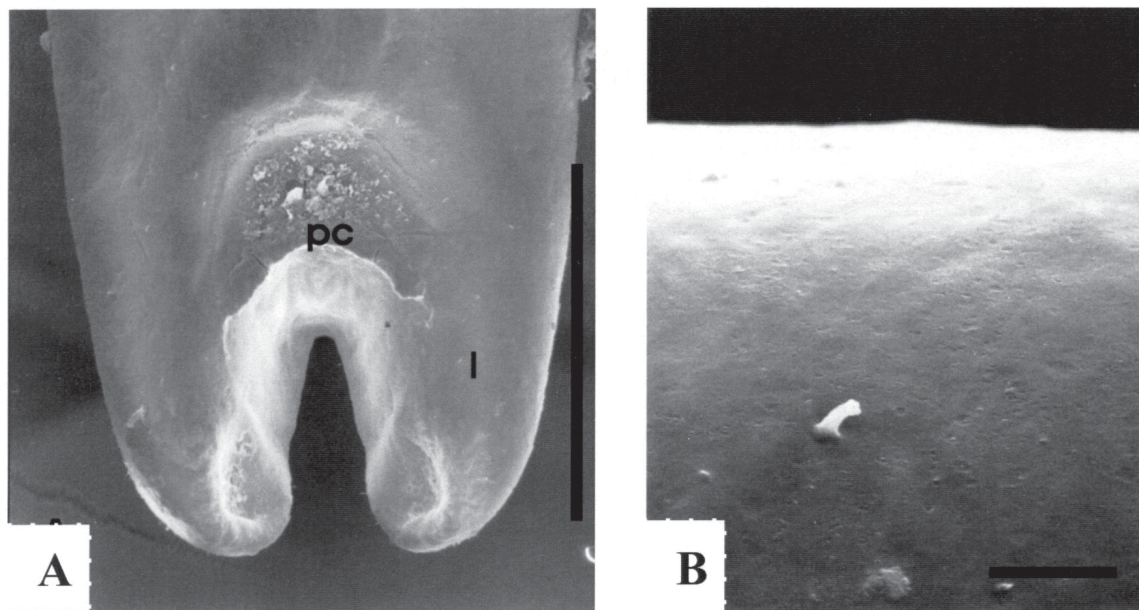


Fig. 5: *Gordius robustus*: male. (A) Posterior end (ventral view); scale: 500 µm. (B) Cuticle of the medial region of the body; scale: 10 µm; reference: pc post cloacal crescent, l lob.

*Gordius robustus*: macho. (A) Vista ventral del extreme posterior; escala: 500 µm. (B) cutícula de la región media del cuerpo; escala: 10 µm; referencia: pc medialuna postcloacal, l lóbulo.

together and enclose a tubercle (megareolar pattern). Shape of areoles varies from rounded to oval and measure from 15.1 to 19.2  $\mu\text{m}$  in diameter. Areolar surface is smooth. Interareolar furrow wide and covered by cuticular cords transversally arranged respect the corporal axis. Interareolar structures are represented by long tubercles (6.8  $\mu\text{m}$ ) and minute fine bristles.

Dimensions: 84 mm length and 0.15 mm in diameter.

Remarks. The presence of a row of bristles anterolateral of the cloacal opening in *Neochordodes meridionalis* can also be observed in the South American nematomorph in *N. australis* Miralles & De Villalobos, 1996a

and in two species of *Chordodes*, *C. matensis* De Villalobos & Miralles, 1997 (De Villalobos & Miralles 1997) and *C. festae* Camerano, 1897 (De Villalobos & Zanca 2001). The megareolar pattern of the cuticle (Schmidt-Rhaesa 2002) present in *Neochordodes meridionalis* has been noted for other species of the genus *Neochordodes* as *N. puntanus* Miralles & De Villalobos, 1996, *N. talensis* (Camerano, 1897) and *N. uniareolatus* Carvalho, 1946 (Carvalho 1946, Miralles & De Villalobos 1996a). This pattern can also be recognized in *Noteochordodes dugesi* (Camerano, 1898) (see Fig. 1 and 2, Miralles & De Villalobos 2000) and *Pseudochordodes bedriagae* (Camerano, 1896) (De Villalobos & Restelli 2001).

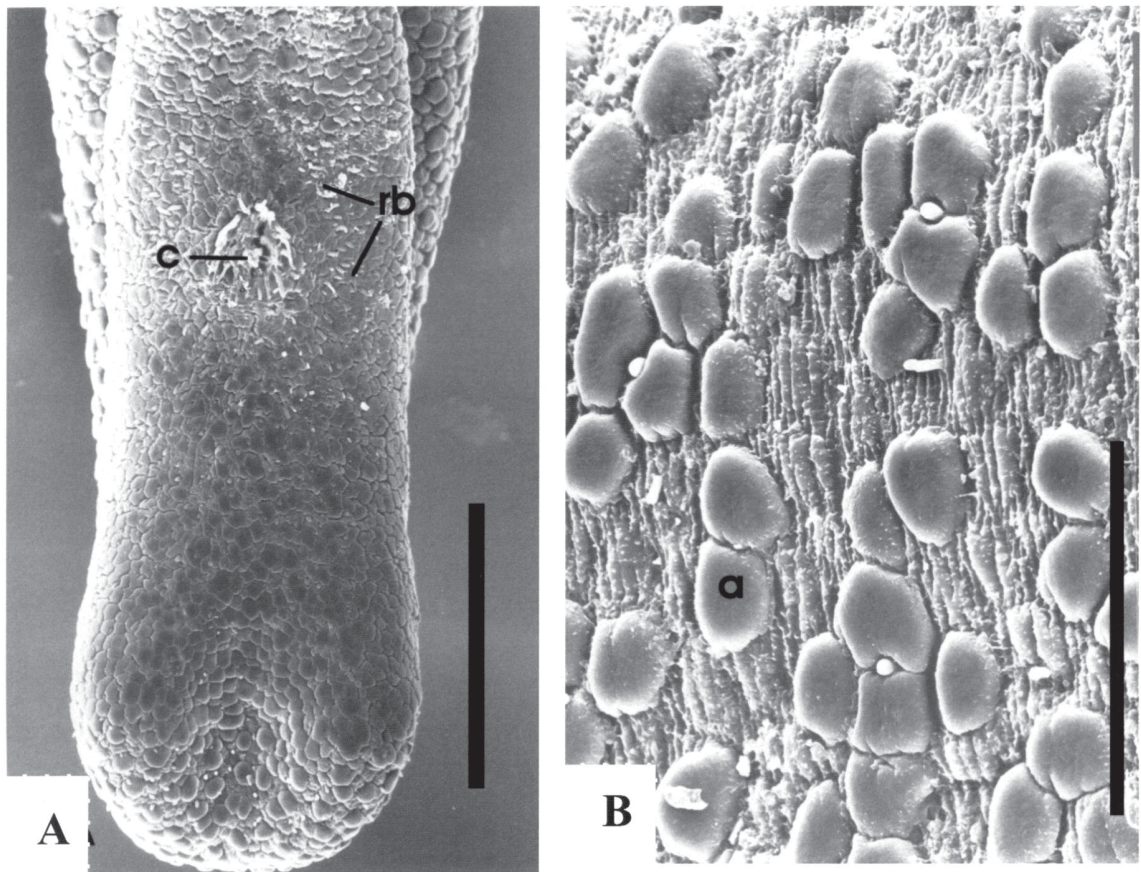


Fig. 6: *Neochordodes meridionalis*: male. (A) Posterior end; scale: 100  $\mu\text{m}$ . (B) Cuticle of the medial region of the body; scale: 50  $\mu\text{m}$ ; referencia: a areole, c cloacal opening, rb rows of bristles.

*Neochordodes meridionalis*: macho. (A) Extremo posterior; escala: 100  $\mu\text{m}$ . (B) Cutícula de la región media del cuerpo; escala: 50  $\mu\text{m}$ ; referencia: a areola, c hendidura cloacal, rb hileras de cerdas.



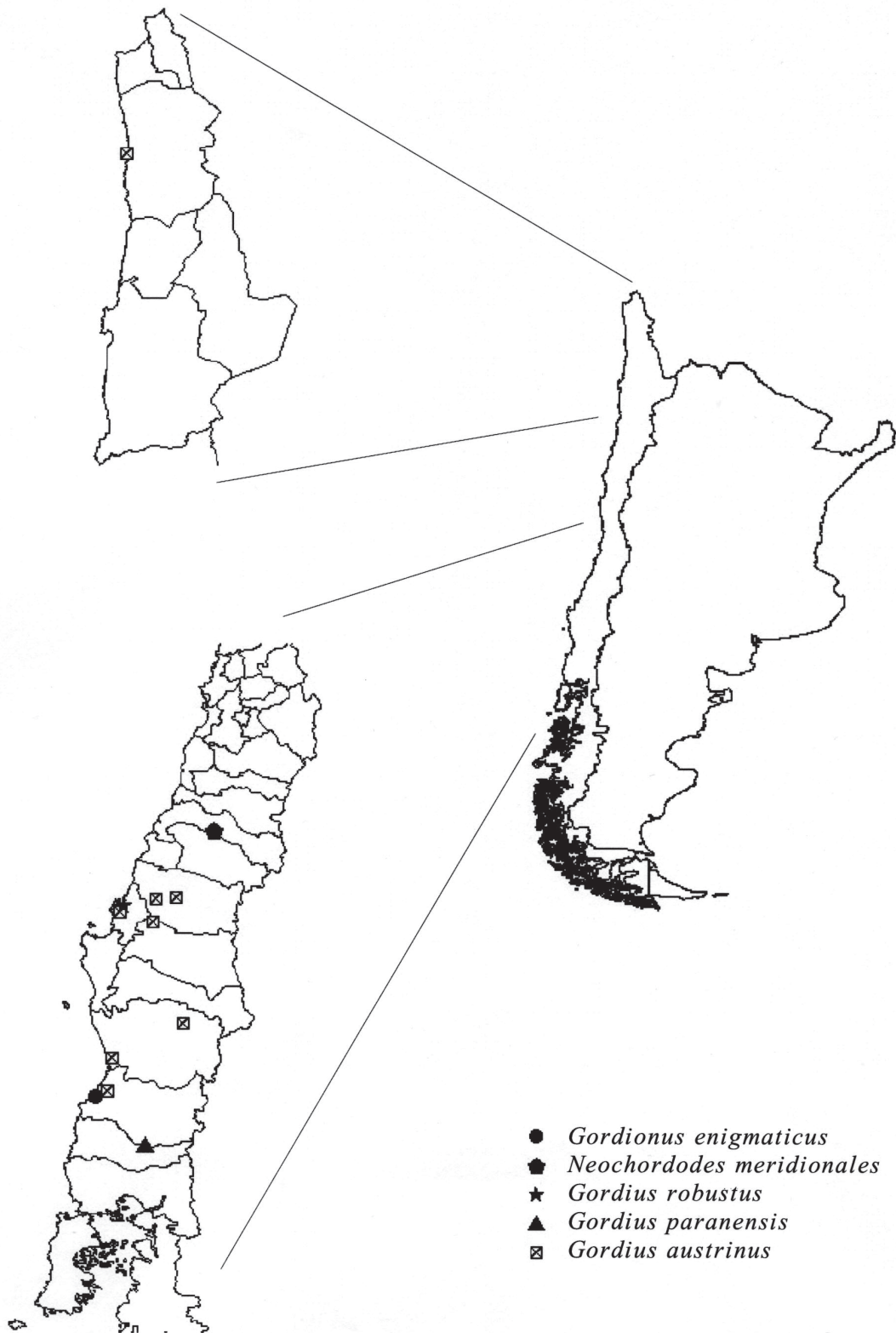


Fig. 7: Distribution of Nematomorpha (Gordiida) in Chile.

Distribución de Nematomorpha (Gordiida) en Chile.

Distribution. Argentina: Buenos Aires, Sierra de la Ventana: El Negro stream two ♂♂, two ♀♀ (Miralles 1977), Sauce Grande stream (five ♂♂, two ♀♀ (Miralles 1980), San Teófilo stream, three ♂♂, one ♀ (Miralles 1980), El Loro stream (eight ♂♂, four ♀♀ (Miralles 1980). La Rioja: (eight ♂♂ (Carvalho & Feio 1950), Neuquén: Confluencia (one ♂, one ♀ (Miralles & De Villalobos 1996a), Barrio Nuevo (one ♂ (Miralles & De Villalobos 1996a). Salta: Zanja Honda, Copaffut (37 ♂♂ (Carvalho & Feio 1950), Campo Quijano (eight ♂♂ (Miralles & De Villalobos 1996a). San Juan: Tumana stream (one ♀ (Miralles & De Villalobos 1996). Chile (Fig. 7): Linares province, Paso Pehuenche (one ♂ new record).

#### DISCUSSION

In Gordiida the taxonomically important characters are almost entirely cuticular structures. These are the structures of the body cuticle and structures at the posterior end, especially in males. Additionally, the general shape of the posterior end is important (De Villalobos & Zanca 2001, Schmidt-Rhaesa 2002). Most of these features are visible with a scanning electron microscope (SEM). Both the coloration pattern and the body length are of questionable value, because these are likely to be variable characters (Schmidt-Rhaesa 1997). We could observe intraspecific variations between specimens of *G. austrinus* and *G. paranensis*. As mentioned before, these differences lack taxonomic value although it is important to mention them at the moment of describing a species. (Camerano 1897, Schmidt-Rhaesa 1997)

We regard at present seven species to be valid for Chile: *Beatogordius latastei*, *Gordionus enigmaticus*, *Gordius austrinus*, *G. paranensis*, *G. robustus*, *Neochordodes talensis* and *N. meridionalis*. Taking into account that from the mentioned species de Chile, *Beatogordius latastei*, *G. robustus*, *Neochordodes talensis* and *N. meridionalis* have been also reported for Argentina (bordering country with Chile), we think that future collections of Gordiida in Chile will allow not only to widen the number of species but also to relate more adequately the Gordiida fauna in both countries. These data together

with the data from other South American countries will give more information on the biodiversity of the Gordiida and will also allow to evaluate if a geographic barrier as the Andes could have an important role in Gordiida speciation events.

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#### LITERATURE CITED

- AGUINALDO AMA, JM TURBEVILLE, LC LINFORD, MC RIVERA, JR GAREY, RA RAFF & JA LAKE (1997) Evidence for a clade of nematodes, arthropods and other moulting animals. *Nature* 387: 489-493.
- BLANCHARD E (1849) Anulares, gusanos y articulados. In: Gay C (ed) *Historia física y política de Chile* 3: 109. Museo Nacional de Historia Natural, Santiago, Chile.
- CAMERANO L (1892) Descrizione di una nuova specie del genere *Gordius* di Palmeira (Parana) raccolta dal Dott. G. Franco Grillo. *Annali del Museo Civico di Storia Naturale di Genova (Italy)* 2: 965-966.
- CAMERANO L (1894) Viaggio del Dottor Alfredo Borelli nella Repubblica Argentina e nel Paraguay. *Gordii. Bollettino dei Musei di Zoologia ed anatomia comparata della R. Università di Torino (Italy)* 9: 1-6.
- CAMERANO L (1895) Description d'une nouvelle espèce de *Gordius* du Chili. *Actes Societe Scientifique Du Chile* 5: 8-9.
- CAMERANO L (1897) Monografia dei Gordii. *Memorie della Reale Accademia della Scienze di Torino, serie II (Italy)* 47: 339-419.
- CAMERANO L (1901a) Gordii raccolti dal Dottor Filippo Silvestri nella Repubblica Argentina e nel Paraguay. *Bollettino dei Musei di Zoologia ed Anatomia comparata della R. Università di Torino (Italy)* 16: 1-2.
- CAMERANO L (1901b) Viaggio del Dr. A. Borelli nel Matto Grosso e nel Paraguay. *Gordii. Bollettino dei Musei di Zoologia ed Anatomia comparata della Real Università di Torino (Italy)* 16: 1-2.
- CAMERANO L (1915) Revisione dei Gordii. *Memorie della Reale Accademia della Scienze di Torino (Italy)* serie II 66: 1-66.



- CARVALHO JC (1946) Gordiaceos do Museu de Historia Natural de Montevideo. Comunicaciones Zoológicas del Museo de Historia Natural de Montevideo (Uruguay) 2: 1-7.
- CARVALHO JC & JL FEIO (1950) Sobre alguns gordiaceos do Brasil e da Republica Argentina (Nematomorpha, Gordioidea). Anais da Academia Brasileira de Ciencias 22: 193-206.
- CHANDLER CM (1985) Horsehair worms (Nematomorpha Gordioidea) from Tennessee, with a review of taxonomy and distribution in the United States. Journal of the Tennessee Academy of Science (USA) 60: 59-62.
- DE VILLALOBOS C & D MIRALLES (1997) Una nueva especie de *Chordodes* (Gordiaceo Nematomorpha) parásita de *Blaptica* sp. (Blaberidae, Blattaria). Comunicaciones dei Musei de Ciencias y Tecnologia. Pontificia Universidade Católica, Série Zoología (Brasil) 10: 45- 51.
- DE VILLALOBOS C & D VOGLINO (2000) Description of a new *Gordionus* species and Redescription of *Gordionus undulatus* (Nematomorpha, Parachordodinae) with scanning electron microscopy. Journal of Parasitology 86: 358- 365.
- DE VILLALOBOS C & F ZANCA (2001) Scanning electron microscopy and intraspecific variation of *Chordodes festae* Camerano, 1897 and *C. peraccae* (Camerano, 1894) (Nematomorpha: Gordioidea). Systematic Parasitology 50: 117-125.
- DE VILLALOBOS C & M RESTELLI (2001) Ultrastructural study of the cuticle and epidermis in *Pseudochordodes bedriagae*. Cell & Tissue Research 305: 129-134.
- DE VILLALOBOS C & M RONDEROS (2003) *Dasyhelea necrophila* Spinelli and Rodriguez 1999 (Diptera Ceratopogonidae), a new paratenic host of *Paragordius varius* (Leidy, 1851) (Gordioida, Nematomorpha). Acta Parasitologica 48: 218- 221.
- DE VILLALOBOS C, A RUMI, V NÚÑEZ, A SCHMIDT-RHAESA & F ZANCA (2003a) Paratenic hosts: larval survival strategy in *Paragordius varius* (Leidy, 1851) (Gordioida, Nematomorpha). Acta Parasitologica 48: 98-102.
- DE VILLALOBOS LC, A SCHMIDT- RHAESA & F ZANCA (2003b) Revision of the genus *Beatogordius* (Gordioida, Nematomorpha) II South American species with inclusion of two new species. Memórias do Instituto Oswaldo Cruz 98: 115-128.
- DE VILLALOBOS, C, EG HANCOCK & F ZANCA (2004) Redescription and sexual dimorphism of *Chordodes balzani* Camerano, 1896 (Nematomorpha). Journal of Natural History 38: 2305-2313.
- EHELERS U, W AHLRICHS, C LEMBURG & A SCHMIDT-RHAESA (1996) Phylogenetic systematization of the Nematelminthes (Aschelminthes). Verhandlungen der Deutschen Zoologischen Gesellschaft 89: 8.
- GAREY JR & A SCHMIDT-RHAESA (1998) The essential role of "minor" phyla in molecular studies of animal evolution. American Zoology 38: 907- 917.
- HANELT B & JJ JANOVY (1999) The life cycle of a horsehair worm, *Gordius robustus* (Gordioidea: Nematomorpha). Journal of Parasitology 85: 139-141.
- HANELT B & JJ JANOVY (2002) Morphometric analysis of nonadult characters of common species of American gordiids (Nematomorpha: Gordioidea). Journal of Parasitology 88: 557-562.
- HANELT B & JJ JANOVY (2004) Untying a Gordian knot: the domestication and laboratory maintenance of a Gordian worm, *Paragordius varius* (Nematomorpha: Gordiida). Journal of Natural History 38: 939-950.
- LATASTE F (1896) Gordius et Mantis. Actes Societe Scientifique Du Chile 6: 71-73.
- LEIDY J (1851) On the Gordiaceae. Proceedings of the Academy of Natural Sciences of Philadelphia (USA) 5: 266.
- MIRALLES D (1976) Notas sobre gordiáceos argentinos I. Neotropica 22: 77-80.
- MIRALLES D (1977) Notas sobre gordiáceos argentinos II. Neotropica 23: 7-10.
- MIRALLES D (1980) Observaciones bioecológicas sobre gordiáceos de Ventania. Neotropica 26: 217-224.
- MIRALLES D & C DE VILLALOBOS (1993) Gordioidea: distribución en la Argentina y la región neotropical. Fauna de Agua Dulce de la República Argentina 13: 5-32.
- MIRALLES D & C DE VILLALOBOS (1996a) Especies de *Neochordodes* de la Argentina (Gordioidea Nematomorpha). Iheringia, Serie Zoología (Brasil) 81: 145-150.
- MIRALLES D & C DE VILLALOBOS (1996b) Dos nuevas especies de gordiáceos para Ventania, Argentina (Nematomorpha). Comunicaciones dei Musei de Ciencias y Tecnología, Pontificia Universidade Católica Porto Alegre (Brasil) 9: 3-9.
- MIRALLES D & C DE VILLALOBOS (1996c) Nuevos *Gordius* para la Argentina (Gordioidea, Nematomorpha). Acta Zoológica Mexicana 68: 67-73.
- MIRALLES D & C DE VILLALOBOS (2000) *Noteochordodes*, un nuevo género para la República Argentina (Nematomorpha, Gordioidea). Revista del Museo de La Plata, Zoología (Argentina) 14: 279-283.
- MONTGOMERY THJ (1898) The Gordioidea of certain American collections with particular reference to the North American fauna II. Proceedings of the California Academy of Sciences, Zoology (USA) 1: 333-344.
- MONTGOMERY THJ (1907) The distribution of the North American Gordioidea, with description of a new species. Proceedings of the Academy of Natural Sciences of Philadelphia (USA) 59: 270-272.
- KRISTENSEN (1995) Are Aschelminthes pseudocoelomate or acoelomate? In: Lanzavecchia G, R Valvassori & MA Candia Carnevalli (eds) Body cavities: function and phylogeny: 44-43. Selected Symposia and Monograph UZI 8 Mucchi, Modena, Italy.
- RÖMER F (1895) Die Gordiiden des Naturhistorischen Museums in Hamburg Zoologische. Jahrbücher für Systematik 8: 790-803.
- RÖMER F (1897) Gordiiden. Abhandlungen Senckenbergischen Naturforschenden Gesellschaft 23: 247-295.
- SCHMIDT-RHAESA A (1996) Zur Morphologie, Biologie und Phylogenie der Nematomorpha. Untersuchungen an *Nectonema munidae* und *Gordius aquaticus* Cuvillier. Verlag, Göttingen, Germany. 276 pp.
- SCHMIDT- RHAESA A (1997) Nematomorpha. In: SchwoerbelJ & P Zwick (eds) Süßwasserfauna von Mitteleuropa: 1-128. Gustav Fisher Stuttgart, Germany. 128 pp.
- SCHMIDT-RHAESA A. (2001) The life cycle of horsehair worms (Nematomorpha). Acta Parasitologica 46: 151-158.

- SCHMIDT-RHAESA A (2002) Are the genera of Nematomorpha monophyletic taxa? *Zoologica Scripta* 31: 185-200.
- SCHMIDT-RHAESA A & R EHRMANN (2001) Horsehair worms (Nematomorpha) as parasites of praying mantid with a discussion of their life cycle. *Zoologischer Anzeiger* 240: 167-179.
- SCHMIDT-RHAESA A & C DE VILLALOBOS (2002) Revision of the genus *Beatogordius* (Gordiida, Nematomorpha). I. African species with inclusion of *Chordodiolus echinatus* (Linstow, 1901). *Annals Musée Royal de l'Afrique Centrale (Zoologie)* 290: 1-25.
- SCHMIDT-RHAESA A, F THOMAS & R POULINS (2000) Redescription of *Gordius paranensis* Camerano 1892 (Nematomorpha), as species new for New Zealand. *Journal of Natural History* 34: 333-340.
- SCHMIDT-RHAESA A, B HANELT & WK REEVES (2003) Redescription and compilation of Nearctic freshwater Nematomorpha (Gordiida), with the description of two new species. *Proceedings of the Academy of Natural Sciences of Philadelphia (USA)* 153:77-117.
- SMITH DG (1994) A revaluation of *Gordius aquaticus difficilis* Montgomery, 1898 (Nematomorpha, Gordioidea, Gordiidae). *Proceedings of the Academy of Natural Sciences of Philadelphia (USA)* 145: 29-34.
- VILLOT A (1874) *Monographie Dragoneaux*. *Archives de Zoologie Experimentale et Génér* 3: 39-72.
- WINNEPENNINCKX B, T BACKELJAU, LY MACKEY, JM BROOKS, R DE WACHTER, S KUMAR & JR GAREY (1995) 18S rRNA data indicate that Aschelminthes are polyphyletic in origin and consist of at least three distinct clades. *Molecular Biology and Evolution* 12: 1132-1137.

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